Claims

1. A method for automatic adjustment of devices having
setting elements, characterized in that the adjustment
comprises the following steps:

a)   Carrying   out   a   first   measurement   of   a
        characteristic curve to be controlled by the
        adjustment at predefined measurement points, the
        or each setting element assuming a first setting,
        the "reference setting",

b)   testing a termination condition and terminating
        the method if this condition is satisfied,
        executing the following steps if the termination
        condition is not satisfied,

c)   modifying the reference setting of a setting
        element and measuring the characteristic curve
        again at predefined measurement points for this
        configuration setting element configuration,

d)   reproducing the initial reference setting of the
        setting element modified in step c),

e)   when there is more than one setting element,
        repeating the steps c) and d) for each setting
        element,

f)   calculating   the   gradient   functions   of   the
        characteristic curve,

g)   calculating new settings of the setting elements
      by minimizing an error function by using the
      measured values obtained in steps a) and c) and
      the gradient functions calculated in step f),
5   - setting the elements to the calculated values,

h)   carrying out the method again, beginning with step
      a), the settings calculated in step g) serving as
      the new "reference setting".
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2. A method according to Claim 1, characterized in that
the starting reference setting of the setting elements
at the beginning of the method

15   -   is assumed in the middle of the respective setting
           range of a setting element or
      -    is predefined by means of values from experience
           or
      -    is determined by a preliminary adjustment method.
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3.   A method according to any preceding claim,
characterized in that after each measurement of the
characteristic curve, a test of the termination
condition is carried out and the method is terminated
25   if this condition is satisfied.

4.   A method according to any preceding claim,
characterized in that the test of the termination
condition comprises an automatic comparison between the
30   measured values of the characteristic curve and
predefinable desired values or desired ranges.

5. A method according to any preceding claim, characterized in that the measurement of the characteristic curve is carried out as a

5   - scalar or
      - vectorial

measurement.

10   6. A method according to any preceding claim, characterized in that, in order to minimize the error function in step g) of the method according to Claim 1,

      - a gradient method and/or
15   - a random method

is used.

7. A method according to any preceding claim,
20 characterized in that the minimization of the error function in step g) of the method according to Claim 1 is terminated

      - if, at one of the measurement points, the
25   difference between the last determined theoretical value of the characteristic curve and the measured value of the characteristic curve assumes or exceeds a first predefinable magnitude (deltaS11max) for the corresponding setting of the
30   setting elements or

      - if at one of the measurement points the difference between the last determined theoretical setting and the corresponding setting of the setting

elements assumes or exceeds a second predefinable
magnitude (deltaEEmax) or

- if in a set of predefinable measurement points the
last determined theoretical values of the
characteristic curve have reached a predefinable
desired value or desired range or

- if in a set of predefinable measurement points the
difference between theoretical values, determined
in successive steps of the minimization method, of
the predefinable measurement points assumes or
falls below a third predefinable magnitude.

8. A method according to Claim 7, characterized in that

- the predefinable magnitudes and/or
- the predefinable measurement points

for each device to be adjusted are determined
individually by means of test measurements.

9. A method according to Claim 7 or 8, characterized in
that the theoretical values of the characteristic curve
are determined by calculating a linear approximation
function of the characteristic curve.

10. A method according to any preceding claim,
characterized in that the gradient of a characteristic
curve (f) is determined in accordance with the
following rule:

fGradient (a, i)   =   df(a, i)/dEE(i)

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$$= (f(a,i,1)-f(a,i,0))/(EE(i,1)-EE(i,0)),$$

where: i = number of the setting element,

a = parameter,

EE = setting element,

$EE(i,0)$ = position of the setting element No. i before the modification of the reference setting,

$EE(i,1)$ = position of the setting element No. i after the modification of the reference setting,

$f(a,i,0)$ = f before the modification of the reference setting of the setting element No. i,

$f(a,i,1)$ = f after the modification of the reference setting of the setting element No. i.

11. A method according to any preceding claim, characterized in that for a characteristic curve which, in addition to the setting of the setting elements, depends on further variable parameters, for each configuration of the setting elements, a measurement of the characteristic curve for a plurality of measurement points is carried out, each parameter assuming a plurality of different values.

12. A method according to any preceding claim, characterized in that the number of measurement points corresponds to the number of setting elements.

13. A method according to any preceding claim, characterized in that the device to be adjusted by means of adjustment is designed as a microwave filter.

5   14. A method according to Claim 13, characterized in that for each configuration of the adjusting elements of a microwave filter, a measurement of the characteristic curve is carried out for a plurality of measurement points, the frequency, as parameter,

10   assuming a plurality of different values.

15. A method according to Claim 13 or 14, characterized in that the measurement points are distributed uniformly only over the filter forward pass range.

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16. A method according to any of Claims 13 to 15, characterized in that the characteristic curve to be controlled describes

20   -   the reflection factor (S11) and/or
     -    the S12 parameter and/or
     -    the S21 parameter and/or
     -    the S22 parameter

25   of a microwave filter.

17. A method according to any preceding claim, characterized in that the calculation of new settings of the setting elements in step g) of the method

30   according to Claim 1 is carried out by the theoretical behaviour of each individual measurement point in the event of a simultaneous change in all the setting elements being simulated by means of linear superposition.

18. An arrangement having a processor which is set up in such a way that a method for automatic adjustment of devices having setting elements can be carried out, the

5   adjustment comprising the following steps:

a)   Carrying out a first measurement of a characteristic curve to be controlled by the adjustment at predefined measurement points, the

10   setting elements assuming a first setting, the "reference setting",

b)   testing a termination condition and terminating the method if this condition is satisfied,

15   executing the following steps if the termination condition is not satisfied,

c)   modifying the reference setting of a setting element and measuring the characteristic curve

20   again at predefined measurement points for this configuration of the setting elements,

d)   reproducing the initial reference setting of the setting element modified in step c),

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e)   in the presence of a plurality of setting elements, repeating the steps c) and d) for each setting element,

30   f) calculating the gradient functions of the characteristic curve,

g)   calculating new settings of the setting elements by minimizing an error function by using the

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measured values obtained in steps a) and c) and the gradient functions calculated in step f),

- setting the elements to the calculated values,

h)   carrying out the method again, beginning with step a), the settings calculated in step g) serving as the new "reference setting".

19. A computer program product, which comprises a computer-readable storage medium on which a program is stored which, after it has been loaded into the memory of a computer, makes it possible for the computer to carry out a method for automatic adjustment of devices having setting elements, the adjustment comprising the following steps:

a)   Carrying out a first measurement of a characteristic curve to be controlled by the adjustment at predefined measurement points, the setting elements assuming a first setting, the "reference setting",

b)   testing a termination condition and terminating the method if this condition is satisfied, executing the following steps if the termination condition is not satisfied,

c)   modifying the reference setting of a setting element and measuring the characteristic curve again at predefined measurement points for this configuration of the setting elements,

d)   reproducing the initial reference setting of the setting element modified in step c),

e)   in the presence of a plurality of setting
      elements, repeating the steps c) and d) for each
      setting element,

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f)   calculating the gradient functions of the
      characteristic curve,

g)   calculating new settings of the setting elements
10   by minimizing an error function by using the
      measured values obtained in steps a) and c) and
      the gradient functions calculated in step f),
      - setting elements to the calculated values,

15 h) carrying out the method again, beginning with step
      a), the settings calculated in step g) serving as
      the new "reference setting".

20. A computer-readable storage medium, on which a
20   program is stored which, after it has been loaded into
     the memory of a computer, makes it possible for the
     computer to carry out a method for automatic adjustment
     of devices having setting elements, the adjustment
     comprising the following steps:

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a)   Carrying out a first measurement of a
      characteristic curve to be controlled by the
      adjustment at predefined measurement points, the
      setting elements assuming a first setting, the
30   "reference setting",

b)   testing a termination condition and terminating
      the method if this condition is satisfied,

executing the following steps if the termination condition is not satisfied,

c)   modifying the reference setting of a setting element and measuring the characteristic curve again at predefined measurement points for this configuration of the setting elements,

d)   reproducing the initial reference setting of the setting element modified in step c),

e)   in the presence of a plurality of setting elements, repeating the steps c) and d) for each setting element,

f)   calculating the gradient functions of the characteristic curve,

g)   calculating new settings of the setting elements by minimizing an error function by using the measured values obtained in steps a) and c) and the gradient functions calculated in step f),
     - setting the elements to the calculated values,

h)   carrying out the method again, beginning with step a), the settings calculated in step g) serving as the new "reference setting".